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Impact of Population Aging on Economic Growth in Selected Developed and Developing Countries

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Population aging is basically a situation which occurs when the median age of a country or region rises due to higher life expectancy rate or decreasing fertility rate. Changes in the population's age structure are influenced by economic factors, living standards, pro-family policies, and advancements in medical care. It is expected that the population aged 60 or above will sharply increase in the whole world till 2050. That will further intensify the demand for health resources required to maintain quality life as per SDG. The aim of this study was to estimate the impact of population aging on economic growth in selected developed and developing countries. The study was based on panel data for the period of 1986 to 2021. Data were taken from World Population Prospectus (WPP) and from World Development Index (WDI). Estimation technique used in the study was PMG/ARDL because the variables were stationary at integrating order zero and integrated order one. GDP growth rate used as dependent variable and aged dependency ratio, saving rates, education, life expectancy and fertility rate were used as independent variables. Results showed that there was a significant relation between population aging and economic growth. Increase in population aging leads to decrease in economic growth.
Keywords: Population aging, Aged dependency, Fertility rate, Mortality rate, Economic growth.

INTRODUCTION

Population aging is considered as most significant social transitions of the 21st century (U.N., 2013). It is a shift of population towards older ages (Gavrilov and Heuveline, 2003). Decrease in fertility rate and an increase in survival rate has led to aging populations. It is basically a process where there is proportionally large share of older people in the total population (Ahmad, 2002). The United Nations defines 60 years as the threshold dividing younger and older age groups. However, age of 65 is used for older persons as a reference point in many developed countries (UNFPA, 2012). Aging process started in many developed countries more than a century ago and population aging 65 and above is increasing more rapidly in developing countries than developed countries (Suzman & Beard, 2011).

Population aging is included in Sustainable Development Goals 2030 to ensure economic progress and development. Only one in four older persons has currently access to pension in the world. SDGs make a commitment to ensure social protection system so that older people of society could obtain benefit and get access to income security (WHO, 2006). It is basically relevant to the goals of ensuring healthy lives, poverty eradication, full employment level, decent work for all people and well-being of people at all ages (Sachs, 2012). Number of an aging population is growing faster than any other age group in the whole world. As a result, share of aging population to total population is rising rapidly everywhere (Borsch, 2005). As the population becomes aged rapidly, governments design innovative policies for older persons to give them health care, employment, housing, infrastructure and social protection (Obi *et al*., 2013).

***Importance of Population Aging*:** Population aging is a challenge because it will be difficult to fulfill the basic needs and health care of aging people in near future. Societies should prepare for these challenges. If prepare well then it will become an opportunity for nations to develop faster. Failure to address the challenges of aging societies could pose significant hazards (Zaidi, 2008). Population aging is a phenomenon which cannot be ignored more because it is expected that out of one in every five persons will be age 65 or over till 2050. In 2015, one person in eight persons was over 60 years old, but it is expected that one in six persons will be older globally in 2030 (Prince *et al*., 2015). By 2050,

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first time in history, population aging sixty five and over will be more than the children under the age of five (Low &Ooi, 2013).

Aging population has positive and negative effects on economy. The benefits of an aging population (discussed in figure 1) are:

1. Baby boom generation in most developed countries being more prosperous, healthier, educated than the previous generation and has different life expectations and experiences from previous generations (Healy, 2004).
2. Aging population provides emotional and financial help to family and friends (Uchino, 2009).
3. There will be more volunteer and less crime in the community (Carrington, 2001).
4. There will be wise consumers and experienced workforce in public institutions (Robson, 2001).

On the other hand, people have to face social, cultural and economic challenges due to aging population at individual, family, society and global level (UNFPA, 2012). Problems which are faced by people age 65 or over are mostly slow increase in income, as a result low private savings (Mitchell, 2016). Family structure is also changing as due to decrease in mortality rate. People are living longer lives and have fewer children (Lee, 2003). As a result, older people have fewer options for care. People have to face many new economic challenges which have large effects on labor supply, savings and trade at the world level (Li *et al*., 2007).

There are also some challenges faced by economy due to aging population. Main challenges due to aging population (discussed in Figure 2) are as under:

1. In rapidly aging societies, there is the fewest number of working age population, which led to shortages in supply of qualified workers. As a result, there is a decrease in productivity and an increase in labor cost. This will push up the wages and cause inflation in society (Banister *et al*., 2012).
2. Due to increase in the aging population, their health care costs also rise. As a result, health care sector faces problems like skills and labor shortages and increase in demand of home care (Reinhardt, 2003).
3. Aging population also cause a rise in the dependency ratio. Countries in which there is a larger share of aging population exists mostly depend upon higher taxes of workers and other public fund programs (Razin *et al*., 2002).
4. An economy having a higher share of retirees and senior citizens has different demand than the economy having a large working age population and higher birth rates. For example, aging societies have great demand for retirees' homes and health care services (Peterson, 1999).

It is needed to choose how to deal with challenges and increase the opportunities for the growing aging population. This will determine the future of society (UNFPA, 2012).

Factors by which trend of aging population occur are increasing life expectancy (LE), decreasing fertility and aging of the baby boom generation (Bloom et al., 2011). Changes in the age structure of people are mainly observed due to decline in number of births, life styles, advances in medical treatment and living standard of people (Dlugosz & Razniak, 2014). Fertility rate has decreased to 2.5 children per woman from 5 children per woman from 1950 to 2013, while life expectancy has risen from 48 years to 68 years from 1950 to today (Prettner, 2013). Due to increase in life expectancy, old age dependency ratio has also increased (Tabata, 2005). LE is expected to increase 80 years in America, Europe, Asia and 70 years in Africa till 2050 (Kinsella & Phillips, 2005).

Our study shows a negative relationship between aging population and GDP per capita. Reduction in GDP growth occurs due to decrease in labor productivity and slow labor force growth (Powell, 2016). Growth is also affected by the life expectancy rate. Effect of LE on growth is positive in economies in which this ratio is relatively low, but it could be negative in economies in which LE is relatively high (Barro & Lee, 1994). This can be explained as: economies with lower life expectancy rate encourage people to save more amounts for old age consumption (Deaton & Paxson, 1994). In this way, aggregate saving rate will increase. As a result, long run economic growth rate will also increase. On the other side, economies with higher LER will increase health care cost burden and lower growth rate of the economy in the long run (Lee, 2003).

We take selected, developed and developing countries and focus on Research question: With the increase in life expectancy through advanced medical treatment; there is increase in share of old age people in population along with decline in fertility rate. The paradigm shift in the population dynamics is how going to affect economic productivity and growth of respective countries.

Many developed countries are facing an increase in number of aging population (U.N., 2013). In 2000, developed countries were home of 38 percent of world's aging persons, but in 2015 this percentage fall to 33 percent and it is expected to fall at 27 percent of world's older persons aging 65 and over till 2030. It is estimated that growth of aging population will slow in coming decades in developed countries (He *et al*., 2016). It is observed that mostly in developed countries, consumption levels of older persons are higher than younger persons which indicate that older people are better-off in these countries as compared to developing countries (Kinsella & Phillips, 2005). Population aging is occurring more rapidly in developing countries where there is a large population of younger people (UNFPA, 2012). At present, in developing countries, two out of every three persons aged 60 or over are living in developing countries (Lloyd & Desai, 1992).

Table 1 show a rising trend of the aging population and highest ratio of aging population exists in Japan, which is 33.1 percent and expected to increase at 37.3 percent till 2030.

Table 1. Increase in Aging population in selected developed and developing countries; Comparative analysis .

Developed Countries					Developing Countries				
	People with or above 60 years (% of population)			Projected Change (%)		People with or above 60 years (% of population)			Projected Change (%)
Countries	2015	2030	2050		Countries	2015	2030	2050	
Japan	33.1	37.3	42.5	9.4	Korea Republic	18.5	31.4	41.5	23.0
Italy	28.6	36.6	40.7	12.1	Thailand	15.8	26.9	37.1	21.3
Germany	27.6	36.1	39.3	11.7	China	15.2	25.3	36.5	21.3
Finland	27.2	31.5	32.4	5.2	Sri Lanka	13.9	21.0	28.6	14.7
Portugal	27.1	34.7	41.2	14.1	Turkey	11.2	17.0	26.6	15.4
Greece	27.0	33.2	40.8	13.8	Malaysia	9.2	14.4	23.6	14.4
Malta	25.6	30.4	36.2	10.6	India	8.9	12.5	19.4	10.5
Sweden	25.5	28.6	29.6	4.1	Indonesia	8.2	13.2	19.2	11.0
France	25.2	29.9	31.8	6.6	Bangladesh	7.0	11.5	24.5	17.5
Denmark	24.7	29.4	29.9	5.2	Pakistan	6.6	8.4	12.9	6.3

Source: World Population Ageing, 2015 Highlights

There is not enough literature available on aging population and its impact on growth in developed and developing countries. We take such selected, developed and developing countries in this study in which rate of aging population is highest and limited work is done earlier on this. Limited empirical evidences are available on aging population and growth of the economy. So, this study would definitely increase our understanding that what will be the effect/s of increase in share of aging population on economic productivity and GDP growth and how we can minimize the effects of an ageing population.

Objectives of the Study

By keeping in view above mentioned gap, we set the following objectives of the study:

1. To evaluate the impact of population aging on economic growth in selected developed countries.
2. To give some policy recommendation in the light of the study.

***Review of Literature*:** Bloom *et al*. (2010) conducted a study on the implications of population aging for economic growth. It was expected that due to increase in aging population; saving rate and labor force participation will fall. As a result, economic growth will also fall. Negative relationship between higher population and population growth rate was witnessed in the study. Shrestha (2000) conducted studies on the aging population in developing countries. Awareness issues regarding aging population remained low in many developing countries, even number of aging persons double or even triple. The ratio of the aging population in developing countries was rising rapidly due to decrease in fertility and broad knowledge of medicine.

Maestas *et al*. (2014) explained the correlation between aging population and economic growth for the period of 1980 to 2010. Study indicated that people consume less in the middle part of age when their income was higher and consume more in old age when income was lower. Results showed that increase in aging population (above the age of 60) had decreased GDP Per Capita. This decrease in economic growth is due to a reduction in the labor supply growth rate or decrease in productivity growth. Dlugosz and Razniak (2014) conducted a study on risk of population aging in Asia. The study indicated that changes in population age can be observed in an economy due to economic changes, demographic growth, and the living standard of people, advances in medicine, social preferences and pro-family policies. These changes lead to shift in age structure which further leads to aging of a society.

Jalal and Younis (2014) explained the concept of aging and elderly in Pakistan for the period of 1990 to 2010. Demographic trends of Pakistan showed that aging population increased by seventy five percent from 1990 to 2010. It suggested that there should control the prices of groceries for an aging population, so that malnourishment could be prevented due to non-availability of proper food. Lee *et al*. (2013) explained the aging population and its effect on economic growth in their study. Partial adjustment model, random effect, fixed effect and ordinary least square model were used in the study. Increase of the aging population in total population had a negative effect on economic growth.

Uddin *et al*. (2016) explained the association between the savings rate, real GDP and dependency ratio of Australia for the period from 1971–2014. The study showed that age dependency ratio had a significant and negative impact on GDP per capita and a positive significant relationship between GDP per capita and working age population. Maestas *et al*. (2016) conducted a study which described the relation between population aging, productivity, labor force and economic growth for the period of 1980 to 2010. Results showed that increase in older population aged above 60 years decreased GDP per capita growth rate. The study indicated that old age and young age workers are part of the production

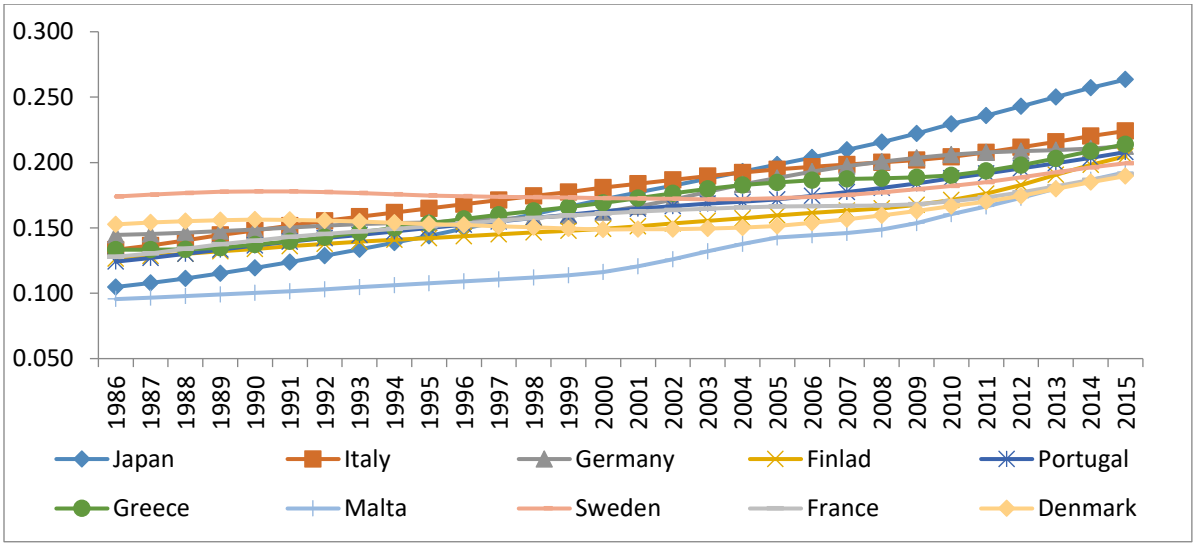
process of an economy so productivity of old age workers affected the productivity of young age workers.

All above studies have highlighted the importance of aging population in economy so this study is going to estimate the effect of aging population on economic growth.

Data and Methodology

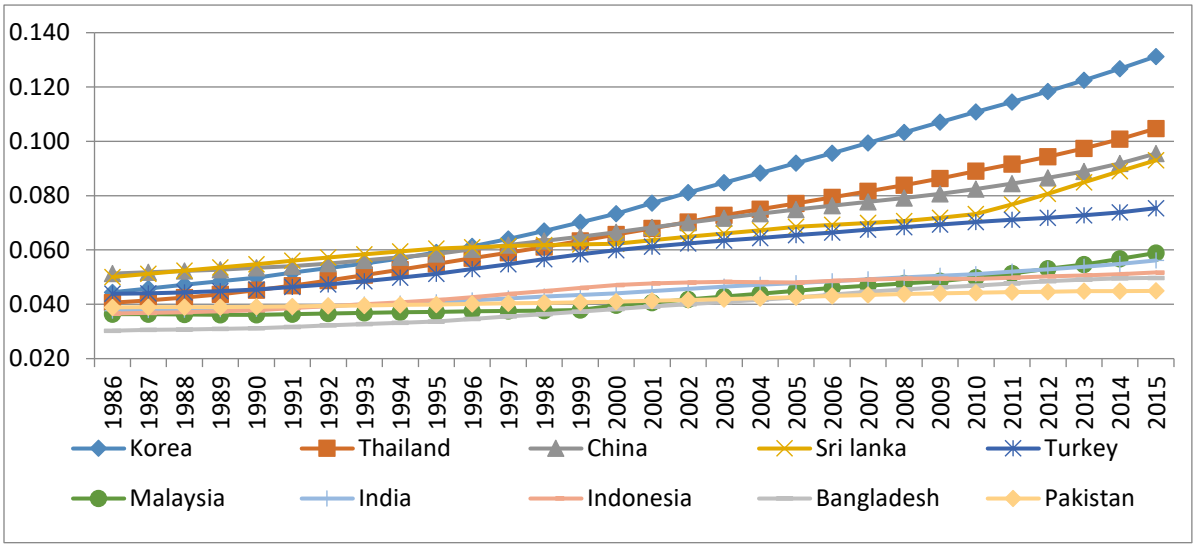
Methodology and techniques that are used to check the impact of aging population on economic growth are discussed here. Two models are used to check the impact on the economy. In the first model, the relation between aging population and economic growth in selected developed countries has been checked. Second model described the relation between aging population and economic growth in selected developing countries. Due to non-availability of data, selected developed and developing countries are used in the study. Those developed countries are taken in which higher ratio of aging population exists and those developing countries are taken in which issue of an aging population is emerging.

This study used secondary data which are taken from World Development Index (WDI) and World Population Prospectus for the time period from 1986-2021. We take selected, developed and developing countries due to non-availability of data. Ten selected, developed countries, i.e. Japan, Italy, Germany, Finland, Portugal, Greece, Malta, Sweden, France



Source: World Development Indicators

Figure 1. Ratio of old age population in developing countries



Source: World Development Indicator

Figure 2. Fertility rate (total births per woman) in developed countries

and Denmark are taken for study. These countries are taken on the base of the highest ratio of the aging population. And ten selected developing countries, i.e. Korea Republic, Thailand, China, Sri Lanka, Turkey, Malaysia, India, Indonesia, Bangladesh and Pakistan are taken. These countries are moving towards an aging population rapidly. In this study, we used PMG-ARDL technique for estimation of results. Reason is that the time period we used were 30 years and variables were stationary at integrating order one I (1) and integrated order zeroes I (0). This estimation technique has multiple advantages as it allowed us to estimate the variables even in mixed integrated order. With the help of PMG-ARDL estimation technique, we find long run as well as the short run relationship between variables.

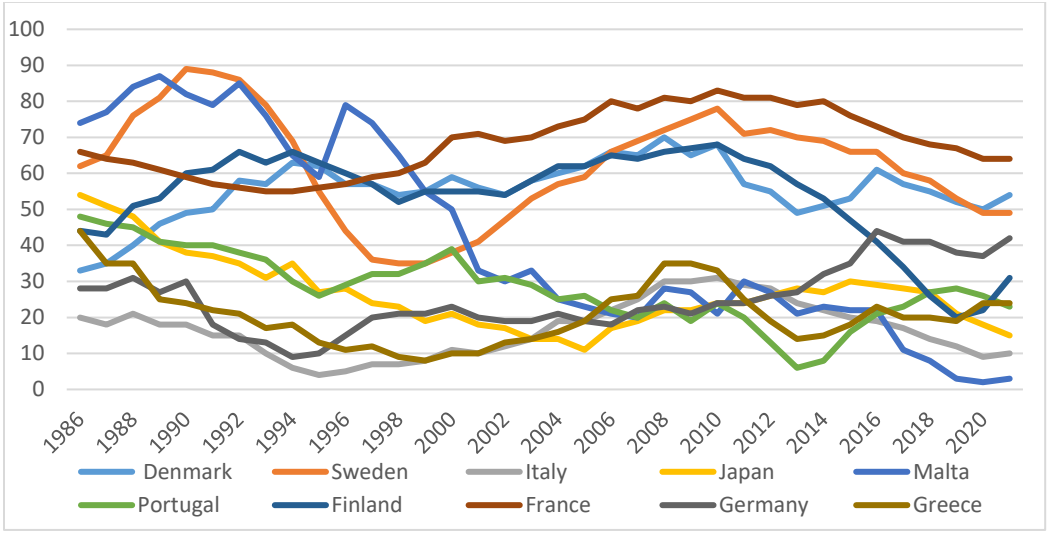
***Development of Models*:** Two models have been developed in order to find out the impact of aging population on economic growth. Model 1 measures the impact of aging population and fertility rate on economic growth in selected developed countries:

$$GGDP = f\,(ADW, SR, EDU, LE, FR, FR^2)$$

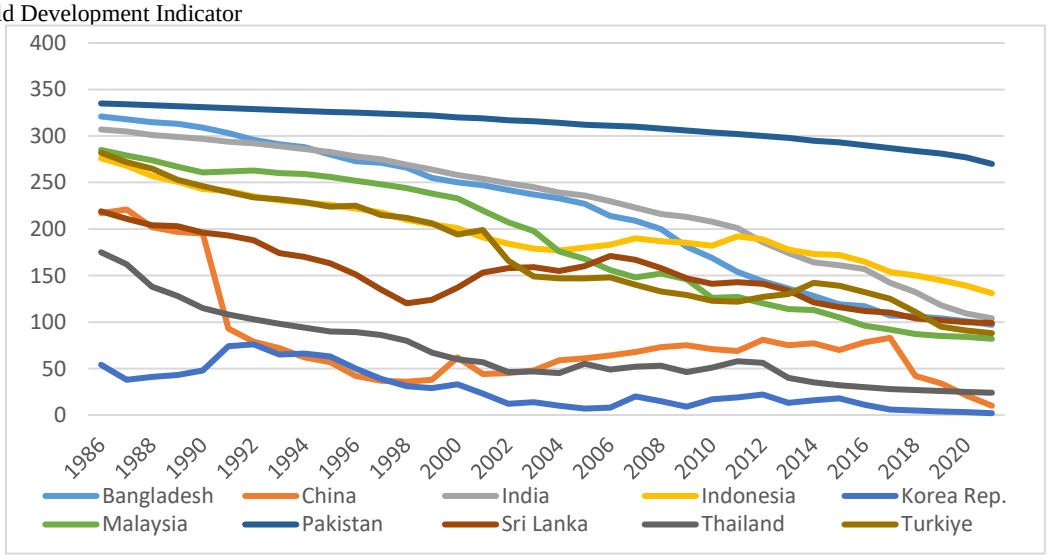
$$GGDP_t = \beta o + \beta_{1t}(ADW) + \beta_{2t}(SR_{2t}) + \beta_{3t}(EDU_{3t}) + \beta_{4t}(LE_{4t}) + \beta_{5t}(FR_{5t}) + \beta_{6t}(FR^2{}_{6t}) + \varepsilon it$$

Model 2 finds the impact of aging population and fertility rate on economic growth in selected developing countries:

$$GGDP_t = \beta o + \beta_{1t}(ADW_{1t}) + \beta_{2t}(SR_{2t}) + \beta_{3t}(EDU_{3t}) + \beta_{4t}(LE_{4t}) + \beta_{5t}(FR_{5t}) + \beta_{6t}(FR^2{}_{6t}) + \varepsilon it$$



Source: World Development Indicator



Source: World Development Indicator (WDI)

Figure 3. Fertility rate (total births per woman) in developing countries

Where, GGDP = GDP Growth Rate; ADW = Aged Dependency on the base of Working Age Population; EDU = Education; SR = Saving rate; FR = Fertility Rate; LE = Life Expectancy; FR^2 = Fertility rate square

RESULTS AND DISCUSSION

On the basis of above given models we draw some results in this chapter. In order to find out short run and long run relationships among variables, the first step is to check the

Table 2. Selected Descriptive statistics developed countries.

	GGDP	AWD	SR	EDU	LE	FR	FR2	MRM1	MRF1
Mean	183.0868	181.6184	153.5526	129.4947	168.2842	37.88947	1973.642	488.7053	163.5500
Median	181.5000	181.5000	151.5000	123.5000	170.5000	32.00000	1024.000	513.5000	162.5000
Maximum	371.0000	371.0000	341.0000	313.0000	350.0000	89.00000	7921.000	703.0000	351.0000
Minimum	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Std. Dev.	107.6041	109.6420	106.7104	101.4195	105.1389	23.22605	1979.094	168.9970	107.6159
Skewness	0.045831	0.005885	0.078936	0.190512	-0.011496	0.287223	0.966883	-1.535183	0.041994
Kurtosis	1.774849	1.792615	1.730559	1.690158	1.783790	1.945280	2.891977	5.465904	1.754851
Jarque-Bera	23.89880	23.08368	25.90972	29.46373	23.42851	22.83836	59.39277	245.5407	24.65962
Probability	0.000006	0.000010	0.000002	0.000000	0.000008	0.000011	0.000000	0.000000	0.000004
Sum	69573.00	69015.00	58350.00	49208.00	63948.00	14398.00	749984.0	185708.0	62149.00
Sum Sq. Dev.	4388306.	4556100.	4315714.	3898359.	4189541.	204451.4	1.48E+09	10824239	4389264.
Observations	380	380	380	380	380	380	380	380	380

Sources: Author's Own Calculation

Above given table shows sources of data and descriptive statistics.

Table 3. Selected Descriptive statistics developing countries.

	GGDP	ADW	SR	EDU	LE	FR	FR2
Mean	181.6184	181.6184	176.7763	88.24474	170.0316	155.8447	7.826004
Median	181.5000	181.5000	176.5000	68.50000	169.5000	150.5000	5.073828
Maximum	371.0000	371.0000	366.0000	258.0000	357.0000	335.0000	42.95492
Minimum	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.557454
Std. Dev.	109.6420	109.6420	109.3847	85.93488	107.9887	99.67324	7.743388
Skewness	0.005885	0.005885	0.013098	0.475519	0.028877	0.085350	2.445218
Kurtosis	1.792615	1.792615	1.784461	1.781204	1.777712	1.821663	9.573498
Jarque-Bera	23.08368	23.08368	23.40519	37.84067	23.70763	22.44559	1062.848
Probability	0.000010	0.000010	0.000008	0.000000	0.000007	0.000013	0.000000
Sum	69015.00	69015.00	67175.00	33533.00	64612.00	59221.00	2973.881
Sum Sq. Dev.	4556100.	4556100.	4534736.	2798840.	4419734.	3765272.	22724.86
Observations	380	380	380	380	380	380	380

Table 4. Long run results of impact of aging population and fertility rate on economic growth in selected developed countries.

Dependent Variable: D(GGDP)
Method: PMG/ARDL Pool mean group /auto regressive distributed lag
Sample: 1986 to 2023 Included observations=340
Maximum dependent lags: 4 (Automatic selection)
Dynamic regressors (4 lags, automatic): AWD SR EDU LE FR FR^2

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Log Run Equation		
AWD	-0.101562	0.053881	-1.884944	0.0629
SR	0.393238	0.045537	8.635656	0.0000
EDU	-0.517633	0.065441	-7.909944	0.0000
LE	-0.004601	0.044402	-0.103629	0.9177
FR	0.224276	1.083358	0.207019	0.8365
FR2	-0.004898	0.009598	-0.510241	0.6112

stationarity of variables. For this purpose, we check the stationerity of variables by the LLC and IPS method. All variables are stationary at integrating order I (0) and integrated order I (1). We check the relationship between variables for selected developed and selected developing countries separately. First of all, we define variables used in study:

The GDP growth rate is used as a proxy of economic growth. Bloom *et al*. (2015), Azomahou and Mishra (2008), Akintunde *et al*. (2013) and Cheng *et al*. (2011) used the same dependent variable as proxy of economic growth.

Independent variables are those variables which effect on the dependent variable. Value of independent variables may be varied in an equation or model. These variables are also known as manipulated variables, explanatory variables or controlled variables. Independent variables which we take in the model are age dependency ratio, saving rates, education, health, fertility rate and mortality rate. By age dependency, we mean population age 65 and above. The aged dependency ratio is calculated by dividing the population aged 65 and above to the population aged 15-64. This variable was used in the literature of Muto *et al*. (2016), Choi and Shin (2015),

Table 5. Short run results of effects of aged dependency on the base of WAP and fertility rate on economic growth in selected developed countries.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Short Run Equation				
COINTEQ01	-1.796585	0.313388	-5.732780	0.0000
D(GGDP(-1))	0.681708	0.258366	2.638534	0.0099
D(GGDP(-2))	0.562922	0.149946	3.754162	0.0003
D(GGDP(-3))	0.236598	0.161144	1.468241	0.1458
D(AWD1)	0.002217	1.643109	0.001349	0.9989
D(AWD1(-1))	-1.044661	1.324333	-0.788820	0.4324
D(AWD1(-2))	1.830698	2.256171	0.811418	0.4194
D(AWD1(-3))	-3.285121	1.408740	-2.331957	0.0221
D(SR)	1.071016	0.375432	2.852757	0.0055
D(SR(-1))	0.025659	0.295890	0.086717	0.9311
D(SR(-2))	0.233996	0.500000	0.467993	0.6410
D(SR(-3))	0.480830	0.456679	1.052883	0.2954
D(EDU)	0.153457	0.606153	0.253166	0.8008
D(EDU(-1))	0.358496	0.355637	1.008039	0.3163
D(EDU(-2))	1.249608	0.808733	1.545144	0.1261
D(EDU(-3))	0.005794	0.313758	0.018468	0.9853
D(LE)	0.725252	0.733522	0.988727	0.3256
D(LE(-1))	-0.802699	0.867358	-0.925453	0.3574
D(LE(-2))	-0.960764	0.758913	-1.265973	0.2090
D(LE(-3))	-0.307766	1.342671	-0.229219	0.8193
D(FR)	5.308494	12.723480	0.417220	0.6776
D(FR(-1))	6.788501	19.102810	0.355367	0.7232
D(FR(-2))	-0.784908	12.613510	-0.062228	0.9505
D(FR(-3))	9.568379	11.922800	0.802528	0.4245
D(FR2)	-0.197368	0.181899	-1.085039	0.2810
D(FR2(-1))	-0.094380	0.200077	-0.471719	0.6384
D(FR2(-2))	0.028335	0.158455	0.178823	0.8585
D(FR2(-3))	-0.088180	0.151303	-0.582801	0.5616
C	420.0674	85.89516	4.890467	0.0000
Root MSE	33.27916	Mean dependent var		-6.535294
S.D. dependent var	117.4948	S.E. of regression		70.78228
Akaike info criterion	10.18217	Sum squared resid		420851.0
Schwarz criterion	13.25136	Log likelihood		-1638.613
Hannan-Quinn criter.	11.40004			

Source: Author's own calculations

Table 6. Long run results of impact of aged dependency on the base of WAP and fertility rate on economic growth in selected developing countries.

Dependent Variable: D(GGDP)
Method: PMG/ARDL Pool mean group /auto regressive distributed lag
Sample: 1986 to 2023 Included observations=340
Maximum dependent lags: 4 (Automatic selection)
Dynamic regressors (4 lags, automatic): AWD SR EDU LE FR FR^2

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Log Run Equation		
ADW	-1.225448	0.132594	-9.242117	0.0000
SR	0.778191	0.071185	10.93193	0.0000
EDU	-0.394245	0.077591	-5.081096	0.0000
LE	0.056803	0.128230	0.442974	0.6589
FR	0.549545	0.172861	3.179113	0.0021
FR^2	22.16995	3.083575	7.189692	0.0000

Source: Author's own calculations

Birdsall *et al*. (2005), Bloom *et al*. (2004), and Choudhry *et al*. (2010).

The amount of money, which we saved over a period of time is called saving. We use, saving rate in the model which is calculated by dividing savings to GDP. Uddin *et al*. (2016), Fougere and Merette (1999), Choudhry *et al*. (2010), Cheng (2011) and Borsch (1995) used the same variable in their literature. Education is taken as a proxy of human development. Human development plays a very important role in the development of a country (Bloom *et al*., 2010). It is a control variable and measured by primary school enrollment (% gross). Health is also taken as a proxy of human development. It is measured by life expectancy. Life expectancy at birth is taken. By life expectancy we mean an average period, which a person is expected to live. Prskawetz *et al*. (2007), Bloom *et al*. (1998), Bloom *et al*. (2010), Zhang *et al*. (2003) and Akintunde *et al*. (2013) used the same variable in their literature. The fertility rate is a control variable which means the average number of children a woman would bear during her lifetime. We take total births per woman. Bloom *et al*. (1999), Bloom *et al*. (2010), Muto *et al*. (2016), Barro (1991, 1994), De Gregorio *et al*. (2008) and Akintunde *et al*. (2013) used the same variable as independent variable.

Here fertility rate in developed and developing countries are shown:

***Source: Author's own calculations*:** Coefficient of ADW is negative, which shows that the aged dependency ratio is negatively correlated with economic growth. Because aged person does not actively participate in growth of an economy. Our results of study are in line with Uddin *et al*. (2016), Prskawetz *et al*. (2007), Maestas *et al*. (2016), Lee *et al*. (2013) and Nagarajan *et al*. (2016)'s findings that the aging population has a significant and negative impact on economic growth. Coefficient of saving rate is positive which means saving rate is positively correlated with economic growth. Because when savings increase in an economy, investment also increases. As a result, growth will increase in an economy. Uddin *et al*. (2016) and Bloom *et al*. (2010) explained same results in their studies. Education has negative impact on economic growth in developed countries. Barro (1991) explained negative relationship between education and growth in his literature.

When life expectancy increase, aging population will also increase, as a result, there will be slower growth. Zhang *et al*. (2003) and Acemoglu and Johnson (2007) in their studies showed that life expectancy has a negative and a smaller impact on economic growth. The relationship between fertility rates and GDP growth rate is positive as a sign of the coefficient is positive. Cheng (2011) and Prettner (2013) explained the same relationship between fertility rates and economic growth. Last variable is the square of the fertility rate, which shows the effect of fertility rate of economic growth if we double the fertility rate. Coefficient shows a negative impact on economic growth. Cheng (2011) explained that higher birth rates are negatively correlated with economic growth.

Short run results of model 1 have been presented in the above table. Short run relationship between variables is determined by error correction model (ECM). ECM shows speed of adjustment of short run equilibrium level to long run equilibrium level. The probability of ECM must be significantly correlated and negative. There exists a long run relationship between our variables may be due to the reason that the growth of an economy is a long running process.

Model 2. Impact of Aging Population and Fertility Rate on Growth in Developing Countries

In 2nd model, the impact of aging population on economic growth is shown in selected developing countries:

Above given table shows the long run relationship between aging population and economic growth in developing countries. GDP growth rate is taken as proxy of economic

Table 7. Short run results of impact of Aged Dependency on the base of WAP and Fertility Rate on economic growth in selected developing countries.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Short Run Equation		
COINTEQ01	-1.173905	0.347622	-3.376957	0.0011
D(GGDP(-1))	-0.046131	0.239766	-0.192399	0.8479
D(GGDP(-2))	0.008784	0.135145	0.065000	0.9483
D(GGDP(-3))	-0.138713	0.200720	-0.691076	0.4914
D(ADW)	-1.941205	5.659845	-0.342978	0.7325
D(ADW(-1))	-0.788729	9.832412	-0.080217	0.9363
D(ADW(-2))	10.22527	6.882755	1.485636	0.1411
D(ADW(-3))	-3.775343	8.064559	-0.468140	0.6409
D(SR)	-0.453990	0.909320	-0.499263	0.6189
D(SR(-1))	0.862365	1.277645	0.674965	0.5016
D(SR(-2))	-1.403947	1.496700	-0.938028	0.3509
D(SR(-3))	2.166499	1.130284	1.916774	0.0587
D(EDU)	-0.116753	0.443114	-0.263483	0.7928
D(EDU(-1))	0.505894	0.327960	1.542551	0.1267
D(EDU(-2))	0.895263	0.302649	2.958089	0.0040
D(EDU(-3))	0.126377	0.257692	0.490421	0.6251
D(LE)	2.641422	1.290527	2.046778	0.0438
D(LE(-1))	-0.578083	1.350270	-0.428124	0.6697
D(LE(-2))	4.617704	5.666583	0.814901	0.4174
D(LE(-3))	4.663056	5.558441	0.838915	0.4039
D(FR)	-9.004324	3.828019	-2.352215	0.0210
D(FR(-1))	4.886724	6.593137	0.741183	0.4606
D(FR(-2))	-20.983220	12.273300	-1.709664	0.0910
D(FR(-3))	-5.105529	4.636997	-1.101042	0.2740
D(FR2)	356.419400	153.063400	2.328574	0.0223
D(FR2(-1))	-188.599400	289.968300	-0.650414	0.5172
D(FR2(-2))	455.433600	252.669300	1.802489	0.0751
D(FR2(-3))	13.633910	179.308800	0.076036	0.9396
C	30.603310	75.570890	0.404962	0.6865

Root MSE	28.04070	Mean dependent var	-4.964706
S.D. dependent var	128.9406	S.E. of regression	59.64045
Akaike info criterion	9.516397	Sum squared resid	298786.6
Schwarz criterion	12.58558	Log likelihood	-1512.115
Hannan-Quinn criter.	10.73426		

*Note: p-values and any subsequent tests do not account for model selection.

Source: Author's own calculations

growth and used as the dependent variable in the model. Coefficient of aged dependency ratio is negative as a sign of the coefficient is negative. The result shows that the aging population has negative impact on economic growth. Coefficient has positive sign means positive impact of life expectancy on economic growth. Square of fertility rate has a significant relationship between fertility rates and GDP growth rate.

Above given are the short run results of models 2. Coefficient of ECM term is negative, which means that our model is converging towards long run equilibrium. ECM coefficient is -2.72 means that the deviation from long run equilibrium is corrected by 272% each year. Negative sign shows that there exists a tendency from short term instabilities to long run equilibrium. There exist a significant relationship between education and economic growth even in the short run.

***Summry and Conclusion*:** In this study impact of population aging on the growth of the economy in selected developed and developing has been checked. Panel data are used for the period of 1986-2021. Pooled mean group/ARDL technique is used in order to check the short run and long run relation among the variables. Two basic models have been developed to check the relation among the variables. In 1st model, the impact of aging population on economic growth in selected developed countries has checked. In 2nd model, the impact of population aging on economic growth in selected developed

countries has checked. The GDP growth rate is dependent variable and used as proxy of economic growth. Aged dependency ratio is measured by population aging 65 and over divided by working age (15-64) population. In model 1, impact of population aging is found negative and significant impact on GDP growth. Education, life expectancy and square of fertility rate also have a negative impact on economic growth, while saving and fertility rate has positive impact on economic growth. In the second model, the impact of population aging on economic growth in selected developing countries has been checked. ADW, SR and EDU have negatively impacted on economic growth while LE and FR have a positive impact on economic growth. Increase in aged dependency leads to decrease economic growth in developing countries. Square of fertility rate shows no significant impact on economic growth.

***5.1 suggestions and policy implications*:** We find in our study that the aging population negatively impact on economic growth and in a coming decade's number of people aged 65 and over will be more than double. It is expected that more growth in aging population will be in developing countries. Population aging will lead to decrease in labor force, decrease in fertility rate and rise in the aged dependency ratio. So following are some suggestions for Govt. and Policy makers**:**

- There should increase in participation rate of older people and make it easier for them to do work till the age of 65 by lowering their working hours.
- Older people should also pay taxes until a later age. In this way the burden of pension will also reduce on the economy.
- In developing countries, working age population is more and labor force participation rate is less. It should ensure to increase the labor force participation rate in developing countries for the growth of the economy.
- The pension should be given to those persons who had low income in their working life and those who do not have any private pension. In this way social and income inequality will reduce. Cost of pension for Govt. will also decrease.
- Private sectors should provide pensions and health care facilities so that dependency ratio can be reduced.
- Gradual retirement will be beneficial for employers, workers and societies as:
- First, gradual retirement allows continuity in tax revenues and expenditure on pension will also reduce; this step will help out in fiscal and macroeconomic stability.
- Second, Older people will be valuable for younger colleagues and their organization due to their experience and knowledge.
- Thirdly, late life work will impact positively on health and well-being of older employees because earlier retirements usually cause stress and tension in older people.

This study is limited to only impact of population aging on economic growth, it is suggested that further research can be conducted by taking other measure like health care cost. We have only focused on selected, developed and developing countries but all the countries can be taken into account.

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